IJC 2009-2011 PRIORITY: ECOLOGICAL IMPACTS OF CHEMICALS OF EMERGING CONCERN

GLBTS Forum

November 30, 2011

Charge from Commission

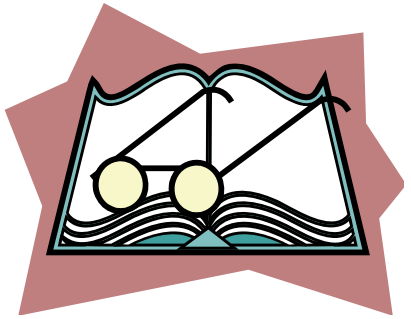
The IJC Multi-board Work Group on Chemicals of Emerging Concern (CEC) directed the Chemicals of Emerging Concern Work Group to further investigate impacts of chemicals of emerging concern on human health and ecology of the Great Lakes near-shore environment.

This presentation covers ecological impacts.

Tasks of the Workgroup

- Literature review of the effects of CECs on aquatic ecosystem biota
- Literature review of available tools and methods to assess ecological effects of CECs
- Develop draft *Strategy for Assessing Exposure to and Effects of Toxic Substances in the Great Lakes* (Effects Strategy)
- Review field studies that investigate ecological effects of CECs in the Great Lakes (ongoing)

Literature Review
CEC Effects



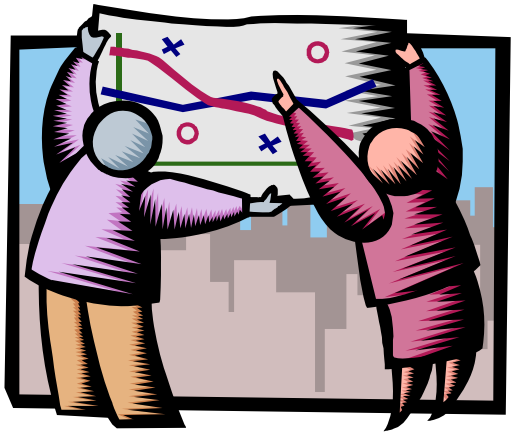
- Included searches of the primary literature, government documents and risk assessments. Studies were evaluated for quality control, including the use of standard methods.

Findings

- Limited data available to characterize eco- effects of CECs.
- Abundance of acute mortality information
- Focus on repro effects and some development effects, but other mechanisms may also be relevant.
- Very little information on population effects.
- ***<u>i.e., what we don't know is a lot</u>***

Recommendations

- A research strategy should be developed to evaluate the risks to the Great Lakes environment posed by chemicals of emerging concern.



Recommendations

Key Gaps which need to be Addressed:

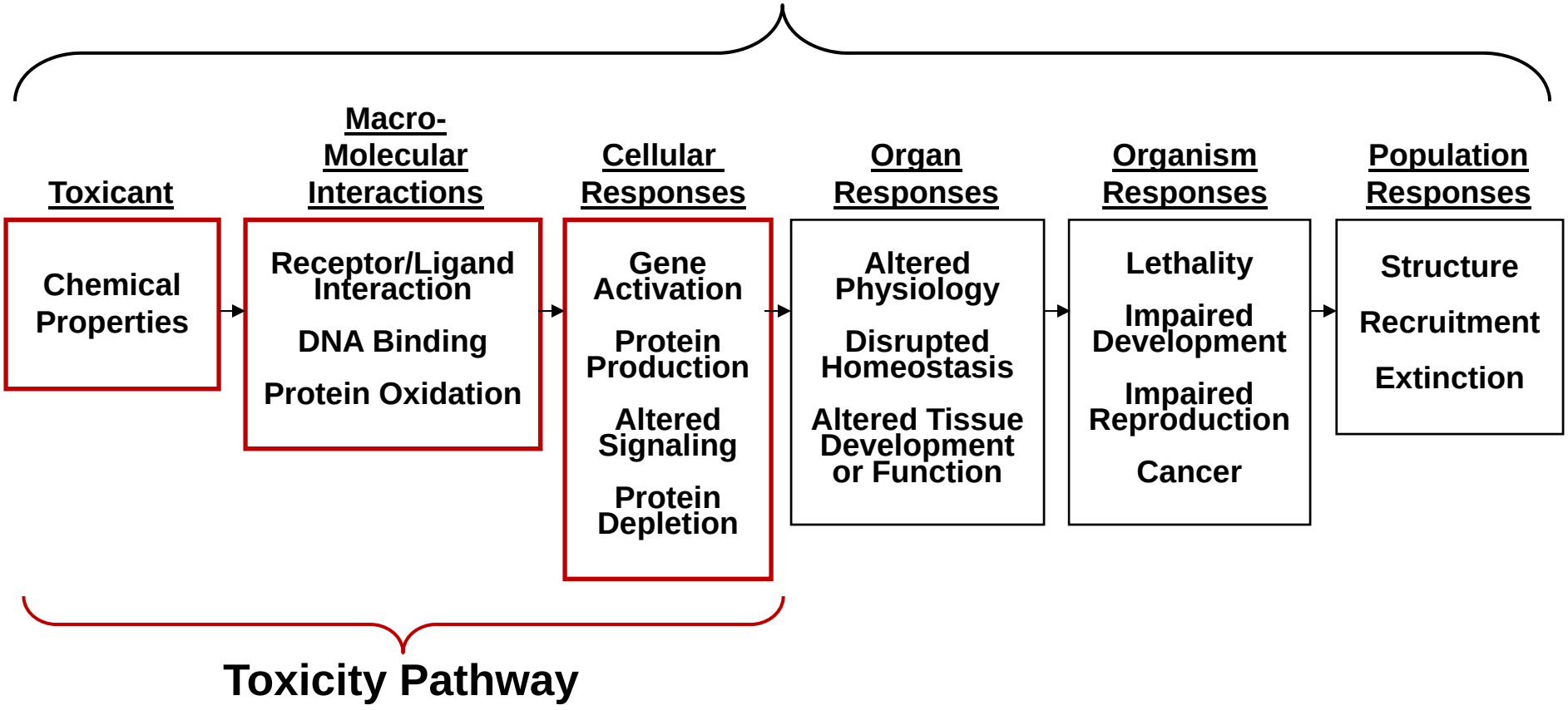
- Link lower levels effects to population level effects
- Sublethal chronic impacts (growth, reproduction, behavior and metabolism) at environmentally realistic exposures
- Impacts of mixtures with traditional pollutants
- Mechanisms of action at low chronic exposure levels
- Methods of measuring effects in the field and methods to tie laboratory studies to field studies
- Impacts of byproducts or metabolites
- Multi stressor impacts

Analysis Of Tools and Methods For Assessing Ecological Effects

Literature Search Approach

- Targeted searches conducted of published and 'grey' literature
- Timeframe –1995 to current

Adverse Outcome Pathway



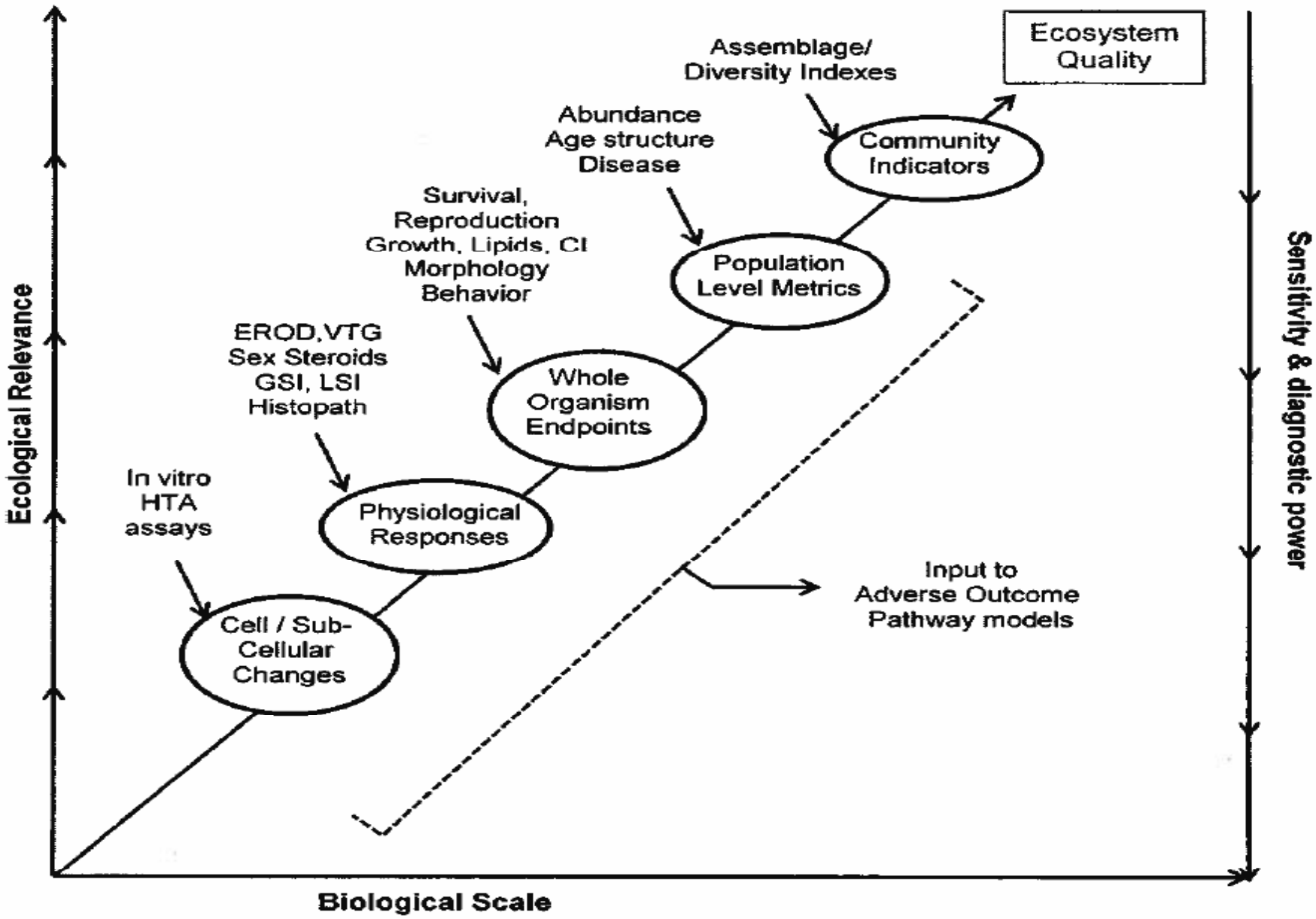


Figure 2. Conceptual description of monitoring tools, biological scale and connection to adverse outcome pathway modeling.

Findings

Six major categories of methods and endpoints:

- Whole Organism/Population (apical)
  - Traditional survival, growth, development, reproduction endpoints
  - Behavioral endpoints
- Methods focused on organ-based system responses
- Cellular/subcellular responses
  - Biochemical markers/enzyme activity/protein-based measurements
  - “Omic” technologies and global assessment of mRNA, protein and metabolite abundance
  - Genotoxicity and mutagenicity

Findings

Promising assays/endpoints in the short term for monitoring toxic chemical effects include:

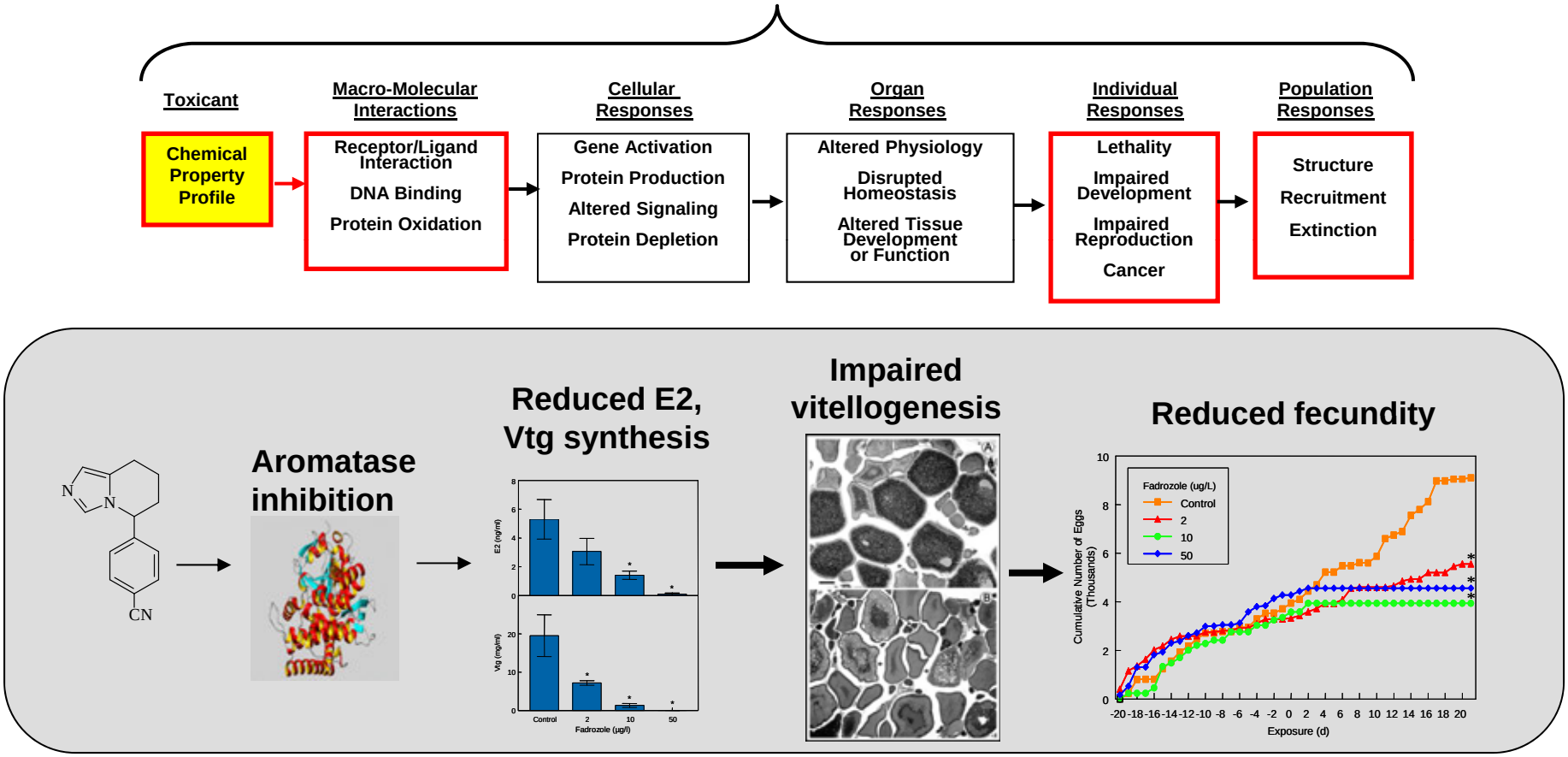
- In vitro (**H4IIE cell or reporter gene bioassays) for Ah receptor agonists is useful in multiple media (sediment, water extracts)**
- In vitro **hormone receptor expression/receptor-binding assays are validated methods for assessing reproductive toxicity in fish, applied to endocrine disruptors**
- **EROD assay – widely used as early warning system to detect Ah receptor interaction in fish, birds, invertebrates**

Findings

Promising assays/endpoints in the short term for monitoring toxic chemical effects include:

- Widely used assays of **VTG induction in fish (both males and females) detect estrogenic and aromatase inhibiting substances, primarily in fish**
- Gonad histology in fish measured in **reproductive toxicity tests using traditional endpoints or in conjunction with steroid concentrations and VTG, for example**
- Morphology changes associated with sexual dimorphism; tumors

Adverse Outcome Pathway



Example of an AOP in fathead minnows exposed to an aromatase inhibitor

Findings (cont)

- Best characterized – apical endpoints
- Increasing use of cellular and sub cellular responses and the integration of methods from different levels of biological organization.
- Limited studies examining field vs lab results
- Several bio-monitoring and chemical monitoring programs serve as examples

Examples of Biological Monitoring Programs

- Canadian Environmental Effects Program
- USGS BEST Program
- NOAA TBiOS

Recommendations

- Develop and implement coordinated strategy for assessing exposure/effects of CECs in Great Lakes basin, based on an ERA framework to guide the design of a biomonitoring program based on clear management goals and objectives
- Conduct pilot studies at sites with the highest likelihood of observing a signal; combine with baseline data-gathering using similar metrics at a broad array of locations.
- Employ site-specific, ecologically relevant, abundant keystone species.
- Conduct additional causal investigations, as required, when adverse effects are observed.

Recommendations

- Utilize a combination of methods and endpoints at all levels of biological organization along the AOP.
- Foster the development of tools currently under development.
- Work toward cyclical monitoring that is standardized across the Great Lakes, adapting the program along the way as science improves.
- Evaluate confounding factors, in addition to CECs, to determine relative risks and causal factors.
- Foster collaboration and sharing of data among jurisdictions.
- Develop a risk communication framework for communicating results to policy makers, researchers, stakeholders and the general public.